Safety and Health Investment Projects
FINAL REPORT REQUIREMENTS

The purpose of the final report of your SHIP project is to:

1. Evaluate and document the achievements, challenges, and shortcomings of the project for the constructive benefit of others interested in learning from SHIP projects; and
2. Provide the Division of Occupational Safety and Health with information that shows:
   a. The outcomes specified in the project application were met; and
   b. The grant was used for the purpose(s) for which it was approved and in accordance with relevant WAC rules and any special conditions or requirements; and
   c. The outputs of the project have been disseminated as specified in the application.

The report format has four sections:

1. Cover Sheet
2. Narrative Report (part I)
3. Financial Information (part II)
4. Attachments (part III)

Please provide complete and detailed information in the final report. If you have questions, please call your SHIP grant manager.

REMINDER!!: All products produced, whether by the grantee or a subcontractor to the grantee, as a result of a SHIP grant are in the public domain and can not be copyrighted, patented, claimed as trade secrets, or otherwise restricted in any way.

SAFETY AND HEALTH INVESTMENT PROJECTS
FINAL REPORT

Determining Best Work Methods In The Logging Industry That Will Reduce MSD Injury Risk By Creating An Objective Data Profile Utilizing Wearable Technology
2016ZC00311
June 6, 2016

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Chilton Logging, Inc. / DorsaVi / Work Right NW, Inc.

10.27.17

By: Nic Patee, DPT

Funding and support for this project has been provided by the State of Washington, Department of Labor & Industries, Safety & Health Investment Projects.

[Chilton Logging, DorsaVi & Work Right NW] is solely responsible for the content of and views expressed in this report and related materials unless they have been formally endorsed by the Washington State Department of Labor and Industries.

PART I

Narrative Report

Abstract:

Present a short overview of the nature and scope of the project and major findings (less than half a page).

Through the course of this study, 128 individual tasks were assessed and 28 comparative analysis conducted in order to develop a set of best practice recommendations for key roles impacted by musculoskeletal disorders in the logging industry. The focus of the study started with baseline assessments using wearable technology to measure the physical demands of 3 key logging roles:

1. Equipment Operator
2. Rigging Men
3. Timber Cutter

Using dorsaVi's proprietary assessment and risk management methodology, each task was categorized according to a potential mitigation strategy. The findings and recommendations for future consideration were captured in a Best Practice "train the trainer" presentation as well as a final report that was delivered to the SHIP program. Further, findings were presented to the industry through presentations at the GOSH Conference, Blue Mountain Safety Conference & twice at the Washington Contract Loggers Association Annual Safety Meeting.

Best practices identified are as follows:

Equipment Operator

1. Use a properly tightened 5 point harness – This demonstrates the benefit of a 5 point harness in the equipment when properly fitted compared to wearing the belt without fitting it to the operator, and/or compared to a traditional lap belt.
2. Antivibration bolts – Demonstrates the benefit of integrating custom bolts to connect the seat to the mainframe of the machine to reduce the impace of whole body vibration.

Rigging Men

1. Pull chokers over the shoulder – demonstrates the benefit of using the over-the-shoulder technique instead of behind the body technique when pulling chokers.
2. Use Hindu Eye on haywire – demonstrates the benefit of using the Hindu Eye for haywire as opposed to the occasionally-used Spliced Eye
3. Pull haywire with mountain climbing harness – demonstrates the benefit of using a centralized pulling point when stringing haywire opposed to the traditional method of pulling behind the body with one arm.
4. Pack gear with bullpack – demonstrates the benefit of spreading the force of the load across the shoulders and back and reducing the variability of an unstable load.

Timber Cutter

1. While multiple assessments were completed on timber cutters, the data did not identify any specific best practices as alternative solutions. More research is recommended to improve work practices in this area before recommendations can be made.

Purpose of Project:

Describe what the project was intended to accomplish.

The logging industry as a whole is a physically demanding job that leads to musculoskeletal limitations, injury or potential disability at a rate higher than most all other risk classifications in the state of Washington. According to the Department of Labor & Industries website "the most common injuries in traditional logging (risk classification 5001-03) occur when workers are struck by an object, fall or suffer a musculoskeletal injury through overexertion or lifting". Further, it was reported that loggers in the state of Washington pay premium rates that range between $6.51 to $26.94 per hour.

On a more personal note, you can rarely go to a logging tower side and find an employee that is working in the field that is older than 50 years of age. If you do happen to find a seasoned logger, than the list of musculoskeletal impairments that that they have will take up a full page of paper (sore back, worn out knees, torn up rotator cuffs, etc.). Loggers are daily wearing down their bodies due to the excessive physical demands of the work environment, the variable working conditions and a lack of understanding of the specific musculoskeletal risk factors in the work environment.

Currently the logging industry is built on tradition. Work methods are past down from generation to generation based on the lessons learned by the generation prior. There is very little scientific analysis and objective information that has been utilized to identify best practices within the industry. What knowledge/training that is out there is largely based on subjective opinion and training by industry experts based on lessons learned from past experience. This is partially true because of the remote locations that loggers operate in, but also due to the limited analysis in the field.

In summary, the problem is very clear. Logging is a physically demanding job classification that is wearing down the musculoskeletal systems of the workforce to the point that they change jobs early in their careers. As the economy is changing, people need to work later in life. Logging needs to identify objective best practices within the trade to eliminate the epidemic of breaking the workforce prior to the age of 50! Further, there is a need to objectively identify, through scientific analysis, what job tasks can be improved to limit the physical demands on the workforce.

The focus of this study was to use wearable technology to objectively quantify the movement profile and muscle activity required in 3 job classifications:

1. Timber Cutter
2. Equipment Operator
3. Rigging Men

Data collection was collected using DorsaVi's ViSafe technology. This technology utilizes wireless sensors placed directly on a worker (while they work in traditional work environments) capturing data on body position & EMG readings at a frequency of 200 frames per second. This data correlates with video that is captured of the task to create a risk profile for the job based on the objective data.

In this project, we started with baseline assessments of the aforementioned Job Classifications. Based on the results of the data, we worked with a Professional Ergonomist, a Team of Physical Therapist's & the Chilton Logging leadership Team to identify the most challenging aspects of the job classifications. From there we created potential solutions to reduce the physical impact on the workers, then measured the results to confirm, or reject our hypothesis. The overarching goal of the project was to identify the challenging physical demands of the logging industry and create solutions that will reduce the physical impact on the workforce. Through this project we were able to identify 6-8 best practices that will reduce the physical impact on the Logging Trade if implemented. Our goal moving forward is to continue to spread the results of the study with the industry and foster further integration into the daily work practice.

The overall objectives of the project were to:

- To utilize scientific analysis to create a deeper understanding of the risks associated with the logging industry related to the musculoskeletal system.
- To create a deeper understanding of ergonomic best practices to reduce the risk of injury/disability in the logging industry.
- To improve job satisfaction and career duration by reducing the cumulative musculoskeletal strain to the body.

Statement and Evidence of the Results:

Provide a clear statement of the results of the project include major findings and outcomes and provide evidence of how well the results met or fulfilled the intended objectives of the project.

The emphasis of this project focused on identifying best practices for reducing the risk of musculoskeletal injuries in the logging industry across 3 main job titles:

1. Equipment Operator
2. Rigging Men
3. Timber Cutter

Using dorsaVi technology we measured the movement profile of the job across the low back upper back & shoulders of workers in these 3 categories. Along with movement analysis, we also measured EMG muscle readings of the lumbar paraspinals, rotator cuff muscles and forearm extensors. Both the movement data and the muscle data was quantified in a dorsaVi Proprietary RAG table that quantifies risk for injury. The standards for dorsaVI's RAG tables are based upon the European Union Directive & Australia's Safe Work Code of Practice. The data was then paired with video of the task to allow the Workshop Team to review the findings, discuss potential interventions & analyze the effectiveness of the interventions.

Our process began with baseline studies in each of the 3 jobs. From there, potential solutions were brainstormed for the high risk tasks that were identified. We then integrated the potential solutions and measured them with dorsaVi technology to determine the effectiveness of the interventions. Essentially, the project followed a kaizen methodology of assess, intervene, re-assess, then apply changes as identified.

Following the initial baseline studies, the following challenges were highlighted:

Equipment Operator

- Forward head & forward lean posture of the operators in the seat
- Variability in the technique for entering / exiting the machines
- Potential challenges associated with whole body vibration

Rigging Men

- Routine challenges with overhead shoulder position throughout the day
- Significant impact to the lower extremities with repeated jumping on/off logs
- Shoulder and lumbar spine challenges with pulling both haywire & chokers
- Significant lumbar spine impact carrying blocks

Timber Cutter

- Challenges with lumbar posture and muscle activity cutting timber
- Challenges with cervical posture when watching the tops of trees
- Differences in gear used to pound wedges
- Significant challenges with variable work environment (i.e. unstable terrain)

From these initial findings we began a series of assessments looking at potential solutions and measured the impact of the solutions. Some "solutions" that we trialed demonstrated positive impacts with a reduction in RAG table risk matrix and reduced physical demands on the body. Some studies that we completed demonstrated no benefit, if not even slightly worse physical demands and were not considered best practices. In order to be determined a best practice, the intervention needed to demonstrate reduced score on the dorsaVi RAG table and reduced physical impact from

the objective data. None of our recommendations were made on subjective feedback, they were all quantified and verified with the analysis of the dorsaVi technology.

A full accounting of all of the interventions, assessments and results can be found in the "VISAFE ASSESSMENT FOR CHILTON LOGGING – Final Report October 27,2017" that is attached with this report.

The final study demonstrated the following Best Practice recommendations:

Equipment Operator

1. Use a properly tightened 5 point harness – This demonstrates the benefit of a 5 point harness in the equipment when properly fitted compared to wearing the belt without fitting it to the operator, and/or compared to a traditional lap belt.
    a. Intial baseline study demonstrated RAG table score of 6 with an individual Back score of 2 & a shoulder RAG score of 4.
    b. Intervention of the properly fitting 5 point harness demonstrated Total RAG score of 3, with individual Back RAG score of 0 & Shoulder RAG score of 3. Demonstrating significantly improved spinal posture while operating the machine.
2. Antivibration bolts – Demonstrates the benefit of integrating custom bolts to connect the seat to the mainframe of the machine to reduce the impace of whole body vibration.
    a. Initial baseline study demonstrated VDV total impact of 19.
    b. Following intervention of the anti-vibration bolts, the VDV value decreased to slightly over 15 with the most significant improvement noted in the X & Z axis.

Rigging Men

1. Pull chokers over the shoulder – demonstrates the benefit of using the over-the-shoulder technique instead of behind the body technique when pulling chokers.
    a. Baseline assessment of pulling chokers the traditional method (one arm pull behind the body) demonstrated a Total RAG score of 12 with both the Back RAG score (7) & the Shoulder RAG score (5) being in the red zone.
    b. Using the over-the-shoulder technique reduced the Total Rag score to 8 with the Back RAG score (4) & the Shoulder RAG score (4) being reduced from the "red" zone to the "yellow" zone.
2. Use Hindu Eye on haywire – demonstrates the benefit of using the Hindu Eye for haywire as opposed to the occasionally-used Spliced Eye
    a. Pulling haywire comparative study was completed using the exact same length of haywire (2 sections) , going down the exact same path on a hillside. We completed the assessment 6 repetitions each (hindu eye vs. spliced eye). RAG table results came out equal (both methods had a RAG score of 9) however EMG data demonstrated 25% less muscle activity in the shoulder EMG & 25.2% less muscle activity in the lumbar EMG using the Hindu eye compared to the spliced eye. Due to the reduced impact on the muscles, it was determined that the Hindu eye was a best practice intervention.

3. Pull haywire with mountain climbing harness – demonstrates the benefit of using a centralized pulling point when stringing haywire opposed to the traditional method of pulling behind the body with one arm.
    a. Pulling haywire the traditional method (one arm pull beside/behind the body) demonstrated a Total RAG score of 8 with the Back RAG score being 4 & the Shoulder RAG score being 4.
    b. Integrating a light weight mountain climbing harness demonstrated a Total RAG score of 3, with the Back RAG score being 2 & the Shoulder RAG score being 1. Both the Back and the shoulder values moved from the yellow/red zones to the green zones with the harness.
4. Pack gear with bullpack – demonstrates the benefit of spreading the force of the load across the shoulders and back and reducing the variability of an unstable load.
    a. Carrying a block with the traditional (over the shoulder) method demonstrated a Total RAG score of 10 with the Back RAG (5) & Shoulder RAG (5) both being in the "red zone".
    b. Using the bullpack demonstrated a Total RAG score of 4 with the Back RAG (1) and the shoulder RAG (3) being in the "yellow zone".

Timber Cutter

1. While multiple assessments were completed on timber cutters, the data did not identify any specific best practices as alternative solutions. More research is recommended to improve work practices in this area before recommendations can be made.

The overarching theme of this project was to identify aspects of the various job titles that were placing the worker in high risk positions for musculoskeletal injuries and identify solutions to reduce the risk for injury. In retrospect, we were able to identify 6 key takeaways that should achieve this objective. Based on quantified data, we can demonstrate best practice techniques that will reduce the physical demands of the muscles & reduce the postural impact on the workers back, shoulders and forearms. This achieved the goal of our study. To add to this, we have further developed a human performance component to our "Train the Trainer" seminar that was developed. This module dives into potential interventions for individuals within the job titles to help improve endurance, strength, agility and flexibility specific to the tasks of their job. This will further improve the overall goal of injury prevention in the logging industry.

Measures to Judge Success:

If relevant, state what measures or procedures were taken to judge whether/ how well the objectives were met and whether the project or some other qualified outside specialist conducted an evaluation.

In this project, we met monthly with a Workshop Committee to review the findings and discuss potential interventions. This Workshop Committee was comprised of Leadership Team Members from Chilton Logging, a professional ergonomist – Matt Marino, feedback from DorsaVi & Leadership Team Members from Work Right NW. The process & data was reviewed by this Team on a quarterly basis to ensure adhearance to the goals of the project, & to drive the success of the project.

Further, routine checkins were completed by the SHIP grant project manager for this grant. Quarterly reports were reviewed and cleared prior to continuation onto the next aspect of the grant. Mid-process, a meeting was set up with the ergonomist for Labor & Industries to review the process and demonstrate case examples from the data. At all times throughout the process of the grant, all objectives were met and progressed to the next stage. These measures ensured a successful completion of the project.

Relevant Processes and Lessons Learned:

Specify all relevant processes, impact or other evaluation information which would be useful to others seeking to replicate, implement, or build on previous work

AND

Provide information on lessons learned through the implementation of your project. Include both positive and negative lessons. This may be helpful to other organizations interested in implementing a similar project.

Processes:

The process for this project was very simple, but used very innovative technology. The overall process followed these steps:

1. Baseline assessments of equipment operator, rigging men & timber cutter with dorsaVi ViSafe technology looking at the spine, shoulders and forearms.
2. Review data in workshop forum with Workshop committee of physical therapists, loggers & professional ergonomist.
3. Recommend potential solutions to highlighted "high risk tasks"
4. Integrate solutions and re-measure the solution with the dorsaVi ViSafe technology to the back and shoulders
5. Repeat this process as challenges, or new potential solutions were identified

From a technology perspective, dorsaVi ViSafe technology was the main assessment tool utilized for this project. We completed 20 assessments over the course of the year guided by the Workshop Team. The studies fell into 2 categories:

1. Longitudinal Studies: in these studies we hooked a worker up to the sensors (to the low back, shoulders and forearm extensors) and had them do their job normally while we captured the data. We had onsite assessors follow the worker around and capture video of the work that synced with the data, so that we had a video feed associated with all data that was captured for further analysis.
2. Comparative Studies: in these studies we hooked workers up to the dorsaVI ViSafe technology in identical fashion to the process with the longitudinal studies, however we were comparing interventions (i.e. what is better? Option A or Option B), so wo captured data in a more controlled environment and repeated it multiple repetitions to ensure consistency of data.

Lessons Learned:

We had multiple lessons learned throughout the process:

1. Scheduling can be challenging when working with industry. We had multiple delays throughout the project related to weather challenges, logging equipment break downs, etc. This led to a slower pace of the project than expected.
2. When possible, in future studies it would be more ideal to control the comparative studies as best as possible to 1 variable. This was difficult in logging because the jobs are so variable that it was difficult to control. In retrospect, some of the baseline studies would have been more effective done in a simulated setting at the shop, compared to doing the assessments in the field. In the future, more care should be taken to understand potential variables in the analysis from the start.
3. While the data of this study demonstrates significant amounts of information related to muscle activity and body position, it would have been valuable to monitor metabolic impact through VO2 measurements, as well as potentially considering other metrics such as heart rate, etc.

Product Dissemination:

Outline of how the products of the project have been shared or made transferrable.

Our focus for dissemination of the grant have been 3-fold:

1. We have generated a Best Practices training that is being delivered to the SHIP program with the final report for dissemination on the State's website.
2. We have presented our findings at 3 large safety conferences in the region (GOSH Conference, Washington Contract Loggers Association Annual Safety Conference & the Blue Mountain Occupational Safety & Health Conference)
3. We have had Timber West (An Industry Publication) out for 2 of our assessments and had many follow up conversations. They have committed to publishing an article regarding the project and include some of the findings in the article.

Beyond this, we are committed to meeting with industry leaders and interested contractors over the course of the next year on a per case basis to deliver Train the Trainer program on our findings and related best practices.

Feedback:

Provide feedback from participants, trainees, individuals who have used your products/processes, as well as any reports from an independent evaluator on the project.

The feedback on the process has been extremely positive. Industry leaders have asked us to present at industry conferences (Washington Contract Logging Safety Conference, Blue Mountain Safety Conference & GOSH Conference) to share the story and findings of our study. Further, we had extremely positive feedback from the workforce engaging in the process. There was no pushback from the workforce in the process.

Project's Promotion of Prevention:

Explain how the results or outcomes of this project promote the prevention of workplace injuries, illnesses, and fatalities?

The results of the project demonstrate some immediate impacts with respect to injury prevention. From a 10,000 foot viewpoint, the project highlighted key areas where the data demonstrated significant postural and EMG risk factors to the back and shoulder:

- Exposure to whole body vibration operating equipment
- Challenges with entry/exit of equipment
- Repetetive overhead shoulder posture working in the rigging
- Repetetive lumbar rotation & side bend pulling chokers
- Heavy liftig of equipment and transporting materials
- Awkward postures that are sustained when cutting timber

More specifically, best practices identified by this project highlighted work methods that will reduce the potential for cumualitive trauma to the back and shoulder. These methods are outlined in the Best Practices Manual that was prepared by DorsaVi. The key takeaways that were identified, when integrated will exponentially reduce the physical impact to the worker. These best practices are as follows:

Equipment Operator

3. Use a properly tightened 5 point harness – This demonstrates the benefit of a 5 point harness in the equipment when properly fitted compared to wearing the belt without fitting it to the operator, and/or compared to a traditional lap belt.
4. Antivibration bolts – Demonstrates the benefit of integrating custom bolts to connect the seat to the mainframe of the machine to reduce the impace of whole body vibration.

Rigging Men

5. Pull chokers over the shoulder – demonstrates the benefit of using the over-the-shoulder technique instead of behind the body technique when pulling chokers.
6. Use Hindu Eye on haywire – demonstrates the benefit of using the Hindu Eye for haywire as opposed to the occasionally-used Spliced Eye
7. Pull haywire with mountain climbing harness – demonstrates the benefit of using a centralized pulling point when stringing haywire opposed to the traditional method of pulling behind the body with one arm.
8. Pack gear with bullpack – demonstrates the benefit of spreading the force of the load across the shoulders and back and reducing the variability of an unstable load.

Lastly, the project highlighted certain job titles & job tasks that were more physically taxing on the body, but may not have ideal engineering solutions. The development of human performance guidelines & micro-stretch break recommendations were developed as part of a "Train the Trainer" program that was developed. These recommendations were specifically tailored to the physical challenges that were identified in the job tasks and when properly utilized should assist in reducing the MSD frequency & severity in the industry.

Uses:

How might the products of your project be used within the target industry at the end of your project?

Is there potential for the product of the project to be used in other industries or with different target audiences?

We see multiple different avenues for this results of this study to be utilized:

1. Best Practices can be immediately disseminated and utilized within the industry. Outside of the anti-vibration bolts that were identified, all of the other best practice solutions were low-cost, easy to integrate solutions that can be quickly applied by the industry to reduce the physical impact on the body.
2. Industry auditing programs (Such as the LSI) inspectors can distribute findings as appropriate to loggers within their portfolio.
3. A "Train the Trainer" program was created integrating the findings from the project and is available through the SHIP program for independent utilization, or members of the project team can be available to develop Live trainings to the industry on a case by case basis.
4. We will continue to participate in industry trade shows to continue to spread the results and share our vision for injury prevention strategies within the logging industry.

Further, we see opportunities for the findings from this study to be utilized in industries with similar tasks. For example, equipment operators in the construction industry may benefit from the vibration studies completed on the logging seats. Further, electicians or longshoremen who are pulling wire frequently may benefit from the recommendations on the climbing harness compared to traditional pulling methods. We strongly believe that there is opportunity for this study to go beyond the logging industry.

Organization Profile:

For awarded organizations, to include partners and collaborators, provide a brief description of each organization. Mission, vision, and purpose for each of the organizations who applied (this includes partners and collaborators) for the grant.

1. Chilton Logging is a fast-growing private logging company in the State of Washington. In the last 15years they have increased the size of their company from 25 employees to nearly 85. Whilegrowing the size of their company, they have also managed to consistently lower their experiencefactor to well below 1.00.
2. DorsaVi has achieved multiple headlines and awards over the years. As an innovative companythat started in professional sport and progressed into occupational safety & health, they haveachieved much acclaim. Some of their most notable achievements are listed below:
    - Won the UK Rail Industry Award for Innovation & Design: http://mhwmagazine.co.uk/dorsaviwins-uk-rail-industry-awards-for-design-innovation.html
    - Endorsed by the Australian Physiotherapy Association: http://get.dorsavi.com/apaendorsement-announcement/

- Feature in Virgen Voyeur for Innovation: http://dorsavi.com/wpcontent/uploads/2016/01/Voyeur-_-Virgin-Voyeur-January-2016-Page-134.pdf
- Partnership Announced with New England Patriots: http://dorsavi.com/wpcontent/sharelink/20150818-dorsavi-signs-new-england-patriots-nfl-and-two-us-universi-75544136486998551.pdf
- Feature on ESPN: http://espn.go.com/espnw/athletes-life/article/13531538/how-prehabturned-runner

3. Matt Marino is a duly-certified Professional Ergonomist & Physical Therapist who specializes in injury prevention and occupational consulting. He has a passion on integrating ergonomics into workplace prevention models. In his career he has been fortunate to work with many fortune 500 companies throughout the United States.
4. Work Right NW is a Team of Board Certified experts in rehabilitation who are committed to using their skills in a model of injury prevention, rather than the traditional model of injury treatment. Work Right partners with corporations to use the skills and knowledge of the experts in the musculoskeletal system to provide proactive tools to organizations to prevent musculoskeletal injuries down the line. The mission of Work Right is to empower the worker with an understanding of preventive education prior to the initiation of symptoms of overuse or cumualative trauma.

Additional Information

Project Type

- ☒ Best Practice
- ☒ Technical Innovation
- ☒ Training and Education Development
- ☐ Event
- ☐ Intervention
- ☒ Research
- ☐ Return to Work
- ☐ Other (Explain):

Target Audience: The Logging Industry, specifically Timber Cutters, Equipment Operators & Rigging Men.

Languages: English

Industry Classification (check industry(s) this project reached directly)

- ☒ 11 Agriculture, Forestry, Fishing and Hunting
- ☐ 21 Mining
- ☐ 22 Utilities
- ☐ 23 Construction
- ☐ 31-33 Manufacturing
- ☐ 42 Wholesale Trade
- ☐ 44-45 Retail Trade
- ☐ 48-49 Transportation and Warehousing
- ☐ 51 Information
- ☐ 52 Finance and Insurance
- ☐ 53 Real Estate and Rental and Leasing
- ☐ 54 Professional, Scientific, and Technical Services
- ☐ 55 Management of Companies and Enterprises
- ☐ 56 Administrative and Support and Waste Management and Remediation Services
- ☐ 61 Educational Services
- ☐ 62 Health Care and Social Assistance
- ☐ 71 Arts, Entertainment, and Recreation
- ☐ 72 Accommodation and Food Services
- ☐ 81 Other Services (except Public Administration)
- ☐ 92 Public Administration

Please provide the following information - - *(information may not apply to all projects)*

# classes/events:	
# hours trained	
# students under 18	
# workers	
# companies represented	
# reached (if awareness activities)	
Total reached	

List, by number above, industries that project products could potentially be applied to.

11, 21, 23

Potential impact (in number of persons or companies) after life of project?

Have there been requests for project products from external sources?

If Yes, please indicate sources of requests:

PART II

Financial Information
Budget Summary

Project Title:	Determining Best Work Methods In The Logging Industry That Will Reduce MSD Injury Risk By Creating An Objective Data Profile Utilizing Wearable Technology		
Project #:	2016ZC00311	**Report Date:**	10.10.17
Contact Person:	Nic Patee	**Contact #:**	360.608.3883
Start Date:	6.6.16	**Completion Date:**	10.10.17

1.	**Total original budget for the project**	$ $131,595.00
2.	**Total original SHIP Grant Award**	$ $131,595.00
3.	**Total of SHIP Funds Used**	$ $121,091.36
4.	**Budget Modifications (= or - if applicable)**	$ $0.00
5.	**Total In-kind contributions**	$ $0.00
6.	**Total Expenditures (lines 3+4+5)**	$ $10,503.64

Instructions:

- Complete the Supplemental Schedule (Budget) form first (on the next page).
- The final report must include all expenditures from date of completion of interim report through termination date of grant.
- Indicate period covered by report by specifying the inclusive dates.
- Report and itemize all expenditures during specified reporting period per the attached supplemental schedule.
- Forms must be signed by authorized person (see last page).
- Forward one copy of the report to **Anar Imin, SHIP Grant Manager** at **PO Box 44612, Olympia, WA 98504-4612**

PART II *(Continued)*

Financial Information
Supplemental Schedules (Budget)

Project Title:	Determining Best Work Methods In The Logging Industry That Will Reduce MSD Injury Risk By Creating An Objective Data Profile Utilizing Wearable Technology
Project #:	2016ZC00311 **Report Date:** 10.10.17
Contact Person:	Nic Patee **Contact #:** 360.608.3883
Total Awarded:	$131,595.00

ITEMIZED BUDGET: How were SHIP award funds used to achieve the purpose of your project?

	Budgeted for Project	Amount Paid Out	Difference
A. PERSONNEL	$29,998.80	$22,306.80	$7,692.00

Explanation for Difference and other relevant information: Following Quarter 1 – One of the solutions recommended by our ergonomist was to look at an Exoskeleton in the field. We redistributed extra funds from Milestone 1 ($4,615.20 from Personel budget & $538.28 from Travel Budget to supplies) This changed our budgets to as follows:

1. Personel: $29,998.80
2. Travel: $3,442.62
3. Supplies: $10,653.58

We were able to complete the project with fewer required days than budgeted in the proposal. Our initial budget allotted for 3 days per assessment for some Grant Participants & 1.5 days per assessment for others. This was budgeted to account for speaking engagements, report creation, trainings, etc. We were able to complete the project in fewer days than predicted resulting in a remaining balance of $9,230.40 in Personnel funds. Following some modification requests to the final report, an additional 4 days of work to build a best practices flyer, additional modifications to the report, etc. This resulted in a final difference of $7,692.00.

	Budgeted for Project	Amount Paid Out	Difference
B. SUBCONTRACTOR	$87,000.00	$86,350.00	$650.00

Explanation for Difference and other relevant information: Due to the challenges with weather this winter, we had to modify our schedule of assessments. As a result, we blended our 3rd & 4th workshop together. This reduced the cost of our contracted Ergonomist by $450. We also budgeted $500 per workshop for the ergonomist, but the charged rate ended up being $450/workshop resulting in $50 surplus for the 3 workshops.

	Budgeted for Project	Amount Paid Out	Difference
29C. TRAVEL	$3,442.62	$1,280.98	$2,161.64

Explanation for Difference and other relevant information: Following Quarter 1 - One solutions recommended by ergonomist was to look at an Exoskeleton in the field. We

redistributed extra funds from Milestone 1 ($4,615.20 from Personel budget & $538.28 from Travel Budget to supplies) This changed our budgets to as follows:

1. Personel: $29,998.80
2. Travel: $3,442.62
3. Supplies: $10,653.58

Mileage was calculated based on an estimated travel of 100 miles per assessment multiplied by the State rate of 0.54 cents per mile. Understanding this, we budged for a total of 60 trips to complete the project for all grant participants.

As the study progressed, it became apparent that the majority of jobs required less than 100 miles per trip & fewer trips were needed than the initial budget. As a result we ended with $2,161.64 in remaining Travel Funds.

	Budgeted for Project	Amount Paid Out	Difference
D. SUPPLIES	$10,653.58	$10,653.58	$0.00

Explanation for Difference and other relevant information: Following Quarter 1 - One solutions recommended by ergonomist was to look at an Exoskeleton in the field. We redistributed extra funds from Milestone 1 ($4,615.20 from Personel budget & $538.28 from Travel Budget to supplies) This changed our budgets to as follows:

1. Personel: $29,998.80
2. Travel: $3,442.62
3. Supplies: $10,653.58

Supplies Spend as follows:

1. DorsaVi: $5,500
2. Work Right NW (Exoskeleton): $5,153.48
3. Total: $10,653.48

Remaining Funds:
1. Total: ($10,653.48 from supplies budget + money carried over from milestone 1 - $10,653.48 spent on supplies) = $0.00

	Budgeted for Project	Amount Paid Out	Difference
E. PUBLICATIONS	$0.00	$0.00	$0.00

$131Explanation for Difference and other relevant information: There was no spend, or budgeted expense in the Publications line item.

	Budgeted for Project	Amount Paid Out	Difference
F. OTHER	$500.00	$500.00	$0.00

Explanation for Difference and other relevant information: There was no difference in the expense of supplies.

	Budgeted for Project	Amount Paid Out	Difference
TOTAL DIRECT COSTS	$131,595.00	$121,091.36	$10,503.64
	Budgeted for Project	Amount Paid Out	Difference
TOTAL INDIRECT COSTS	$0.00	$0.00	$0.00

	Budgeted for Project	Amount Paid Out	Difference
TOTAL SHIP BUDGET	$131,595.00	$121,091.36	$10,503.64

	Budgeted for Project	Amount Paid Out	Difference
G. IN-KIND	$0.00	$0.00	$0.00

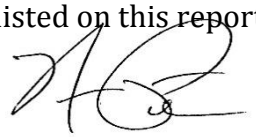
Explanation for Difference and other relevant information: Work Right did provide multiple in-kind contributions, however this was not reimbursed. In-kind contributions included the following:

- Cost of travel, hotel accomodations & ½ the cost of the exoskeleton for the initial exoskeleton trial.
- Purchase of bullpack & mountain climbing harness for hook tender comparative study
- Purchase of anti-vibration seat cushion

Red Wood Plastics provided in-kind contribution of an engineer specializing in anti-vibration plastics. They provided the following in-kind contributions:

- Trial "engineered anti-vibration attachment point" for the seat to the mainframe of the shovel
- All time and supplies were provided at no-cost by Red Wood Plastics in Woodland, WA.

I hereby certify that the expenditures listed on this report were made with my approval:



1.3.2018

Date

Signature of Project Manager

PART III
Attachments:

Provide resources such as written material, training packages, or video/ audio tapes, curriculum information, etc. produced under the grant.

Also include copies of publications, news releases, curriculum, posters, brochures, etc.

The above information should also be provided on a CD or DVD for inclusion in the file.

- DVD: must be in an MP4 format
  Other video files must be provided in uncompressed source files.

- Publications:
  PDF of publication should be provided. SHIP also needs the original publishing documents (design documents), .eps, and .psd (if any illustrations/graphics are used)

REMINDER!!: All products produced, whether by the grantee or a subcontractor to the grantee, as a result of a SHIP grant are in the public domain and can not be copyrighted, patented, claimed as trade secrets, or otherwise restricted in any way.